North Dakota Automated Manufacturing

Content Standards

Approved & Adopted
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Table of Contents

INTRODUCTION TO THE CTE STANDARDS

CTE Mission

The mission of the State Board for Career and Technical Education is to work with others to provide all North Dakota citizens with the technical skills, knowledge, and attitudes necessary for successful performance in a globally competitive workplace.

Goal

Career and Technical Education (CTE) is a series of educational programs organized to prepare students for careers in their chosen fields, to take leadership roles, and to balance their multiple roles in life. The CTE goal is to create a competitive and knowledgeable work force. CTE programs prepare students with the knowledge and skills to make informed career choices, to integrate and apply academic concepts, to prepare for successful participation in a global society, and to engage in lifelong learning.

The North Dakota standards for each CTE program define expectations for student learning. These expectations guide the development of high-quality and relevant career-focused programs that are consistent across the state.

Process

Writing standards is a multi-phase process. Existing national and/or industry standards are the basis for the North Dakota program standards. In addition, standards from other states are reviewed for essential content. A team of expert secondary and postsecondary teachers, business and industry representatives, and the state program supervisor(s) draft the standards document. Once the document is finalized, the State Board for Career and Technical Education approves and adopts the standards. The standards documents are reviewed and updated on a four-year cycle. Further information on the standards can be found at: http://www.nd.gov/cte/services/standards/

Academic Integration

The Department of Career and Technical Education strongly believes in the importance of academic integration within each program. CTE courses are a vehicle by which students can apply academic knowledge to everyday life. Each standards document includes an academic cross-walk that identifies the standards in English/Language Arts, Mathematics, and Science that relate to CTE standards and can be taught or reinforced in the CTE program.

Using the Standards

Districts will use the standards as guides for developing curriculum that reflects local needs and are also tailored to prepare young people for the opportunities that exist in North Dakota and elsewhere.

Standards and Topics At A Glance

1.0 BENCH WORK

- 1.1 Measurement
- 1.2 Safety
- 1.3 Materials
- 1.4 Engineering Drawing and Layout
- 1.5 Tools
- 1.6 Processes

2.0 MANUAL MACHINING PROCESSES

- 2.1 Measurement
- 2.2 Safety
- 2.3 Drawing and Layout
- 2.4 Metal Characteristics
- 2.5 Drills and Drilling Machines
- 2.6 Offhand Grinding
- 2.7 Sawing and Cutoff Machines
- 2.8 The Lathe
- 2.9 Broaching Operations
- 2.10 The Milling Machine

3.0 WELDING

- 3.1 Safety
- 3.2 Measurement
- 3.3 Drawings
- 3.4 Materials
- 3.5 Tools
- 3.6 Welding Processes
- 3.7 Welding Theory

4.0 AUTOMATED MANUFACTURING

- 4.1 Computer Aided Machining Technology
- 4.2 Automated Manufacturing

5.0 FORCE AND FORCE TRANSFORMERS

- 5.1 Mechanical
- 5.2 Electrical
- 5.3 Fluid Force
- 5.4 Thermal Force

Organization of the Standards Document

Standard: provides a broad overview or general description of the content.

Topics: describe in general terms what students should know and be able to do.

Competencies: more specifically define the knowledge, skills, and practices of topics and provide the basis for measuring student learning.

Standard 1: Career, Community and Family Connections – Integrate multiple life roles and responsibilities in family, work, and community settings. *(Based on National Standard # 1)*		
Topic 1: Analyze strategies to manage multiple life roles and responsibilities.		
Introductory	**Core**	**Advanced**
	1.1.1 List and describe trends in the workplace and community that impact individuals and families (e.g., policies, issues, ethics, worker benefits, etc.) 1.1.2 Describe how individual career goals can affect the family 1.1.3 Set personal goals for learning and leisure. 1.1.4 Predict the potential impact of career path decisions on balancing work and family.	1.1.5 Analyze the impact of social, economic, and technological change on work and family dynamics 1.1.6 Develop a life plan for achieving individual, family, and career goals

Automated Manufacturing Competency Categories

The competencies are further categorized into three divisions: Introductory, Core, and Advanced.

Advanced
Learners at this level **analyze, synthesize, judge, asse**ss and **evaluate** knowledge in accord with their own goals, values and beliefs, and/or real situations.
Core
Learners at this level **experience** acquired knowledge by **applying** it to familiar situations and to themselves.
Introductory
Learners at this level **explore** and become more **aware** of the content within the subject.

Keys to Employability

The eight skills are based on materials gathered from the North Dakota Career Resource Network and the National Career Development Guidelines. These national skills standards, developed by industry groups and sponsored by the U.S. Department of Education and Labor, provide career and technical educators with the expectations of employers across the United States.

Basic Skills

- Reading-locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules.
- Writing-communicates thoughts, ideas, information, and messages in writing; creates documents such as letters, directions, manuals, reports, graphs, and flow charts.
- Arithmetic/Mathematic – performs basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques.
- Listening – receives, attends to, interprets, and responds to verbal messages and other cues.
- Speaking – organizes ideas and communicates orally.

Personal Qualities

- Responsibility – exerts a high level of effort and perseveres towards goal attainment.
- Self-Esteem – believes in own self worth and maintains a positive view of self.
- Sociability – demonstrates understanding, friendliness, adaptability, empathy and politeness in group setting.
- Self Management – assess self accurately, sets personal goals, monitors progress, and exhibits self-control.
- Integrity/Honesty – chooses ethical courses of action.

Keys to Employability (Continued)
Technology • Selects Technology – chooses procedures, tools or equipment including computers and related technologies. • Applies Technology – understands overall intent and proper procedures for setup and operation of equipment. • Maintains and Troubleshoots Equipment – prevents, identifies, or solves problems with equipment, including computers and other technologies.
Systems • Understands Systems - knows how social, organizational, and technological systems work and operates them effectively. • Monitors and Corrects Performance - distinguishes trends, predicts impacts on system operations, diagnoses deviations in systems' performance and corrects malfunctions. • Improves or Designs Systems - suggests modifications to existing systems and develops new or alternative systems to improve performance.
Thinking Skills • Creative thinking –generates new ideas. • Decision making – specifies goals. • Problem Solving – recognizes problems and devises and implements plan of action. • Seeing Things in the Mind's Eye – organizes, processes symbols, pictures, graphs, objects and other information. • Knowing How to Learn – uses efficient learning techniques to acquire and apply new knowledge and skills. • Reasoning – discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem.
Resources • Time – selects goal-relevant activities, ranks them, allocates time, and prepares and follows schedules. • Money – uses or prepares budgets, makes forecasts, keeps records, and makes adjustments to meet objectives. • Material and Facilities – acquires, stores, allocates, and uses materials or space efficiently. • Human Resources – assesses skills and distributes work accordingly, evaluates performance and provides feedback.
Information • Acquires and Evaluates Information. • Organizes and Maintains Information. • Interprets and Communicates Information. • Uses Computers to Process Information.
Interpersonal • Participates as a Member of a Team - contributes to group effort. • Teaches Others New Skills • Serves Client/Customers - works to satisfy customer's expectations. • Exercises Leadership - communicates ideas to justify position, persuades and convinces others, responsibly challenges existing procedures and policies. • Negotiates - works toward agreements involving exchange of resources; resolves divergent interests. • Works with Diversity - works well with men and women from diverse backgrounds.

AUTOMATED MANUFACTURING STANDARDS		
Standard 1: Bench Work		
Topic 1: Measurement		
Introductory	**Core**	**Advanced**
1.1.1 Identify basic measuring tools and gages and explain how they are used 1.1.2 Measure to 1/32" and 0.5 mm with a steel rule 1.1.3 Measurements to 0.001" and 0.01mm with a micrometer caliper	1.1.4 Use a Vernier micrometer caliper to read measurements to 0.0001" and 0.002 mm 1.1.5 Explain how to make readings with common Vernier measuring tools 1.1.6 Identify different types of gages and demonstrate how they are used to check sizes	1.1.7 Demonstrate to use Vernier caliper measuring tools 1.1.8 Demonstrate the ability to make accurate measurements on parts
Topic 2: Safety		
Introductory	**Core**	**Advanced**
1.2.1 Justify the importance of practicing safe work habits 1.2.2 Summarize the general safety practices observed in metalworking 1.2.3 Demonstrate the safe and correct use of manual and electric/pneumatic hand tools 1.2.4 Summarize hand threading safety rules	1.2.5 List common safety equipment and protective clothing 1.2.6 Apply safe work habits when operating machinery 1.2.7 Identify and avoid unsafe work practices 1.2.8 List the hazards posed by metals and use the safety precautions followed in industry 1.2.9 Create safe setups on a drill press 1.2.10 Demonstrate the safe operation of a power saw 1.2.11 Demonstrate hand forging safety rules	
Topic 3: Materials		
Introductory	**Core**	**Advanced**
1.3.1 Define how metals are classified 1.3.2 Describe the properties and characteristics of many different metals 1.3.3 Identify how metals are measured and purchased for industrial use	1.3.4 Describe the characteristics of different types of steel and list the methods used to identify steels	

Topic 4: Engineering Drawing and Layout		
Introductory	**Core**	**Advanced**
1.4.1 Interpret drawings dimensioned in fractional and decimal inches and metric dimensions 1.4.2 Identify the different types of information indicated on a typical technical drawing 1.4.3 Complete a project plan sheet	1.4.4 Describe how detail, assembly, and subassembly drawings differ and identify standard drawing sheet sizes 1.4.5 Demonstrate the geometric dimensioning and tolerancing system 1.4.6 Describe the purpose of a layout and hot it is used to prepare metal for machining 1.4.7 Create a simple layout 1.4.8 Describe how threads are specified on drawing 1.4.9 Describe the need for patterns and stretchouts in sheet metal 1.4.10 Create the different methods of sheet metal pattern development	
Topic 5: Tools		
Introductory	**Core**	**Advanced**
1.5.1 Identify basic hand tools used in metalworking 1.5.2 Identify the correct tool for a given job 1.5.3 Explain the proper procedures to maintain tools 1.5.4 Identify common hand tools that are used to cut and separate material 1.5.5 Identify common hand tools that are used to join and fasten material 1.5.6 Explain the operation of typical grinding machines 1.5.7 Adjust and prepare a grinding machine for operation	1.5.8 Select the correct drills and drilling machine for a given job 1.5.9 Identify drill size classifications 1.5.10 Describe the operation of the three principal metal-cutting power saws 1.5.11 Demonstrate how to select and mount the proper blade for a job 1.5.12 Prepare a power saw for operation 1.5.13 Mount work properly for sawing 1.5.14 Describe the operation of several types of precision grinding machines	

Topic 6: Processes		
Introductory	**Core**	**Advanced**
1.6.1 Explain thread nomenclature	1.6.11 Identify the tools used in hand forging	1.6.22 Describe how broaching operates
1.6.2 Select the proper tap(s) and tap wrench for each job	1.6.12 Demonstrate several forging techniques	1.6.23 Describe the advantages of broaching
1.6.3 Determine the correct tap drill size for specified threads	1.6.13 Bend, draw out and upset metal by hand forging	1.6.24 Set up and cut a keyway using a keyway broach and arbor press
1.6.4 Adjust a die for different classes of fits	1.6.14 Describe industrial forging processes	1.6.25 Perform reaming, spotfacing, countersinking and counterboring operations using a drill press
1.6.5 Demonstrate how to use, clean and store threading tools properly	1.6.15 Describe the reasons for heat treating metals	1.6.26 Describe several cold forming operations
1.6.6 Cut and bend sheet metal using a number of tools	1.6.16 Summarize the principles of several heat treating processes	1.6.27 Discuss how shearing, blanking, and piercing operations differ
1.6.7 Make hems, edges, and seams in sheet metal	1.6.17 Demonstrate basic heat treating processes	1.6.28 Describe how many of the cold forming operations are accomplished
1.6.8 Demonstrate forming sheet metal into three dimensional shapes using special machines	1.6.18 Describe how some hardness testers operate	1.6.29 Perform cold forming operations
1.6.9 Join sheet metal sections with solder and rivets	1.6.19 Perform a precision grinding operation	1.6.30 Describe the application of several quality control techniques
1.6.10 Explain the necessity for quality control	1.6.20 Explain two classifications of quality control	
	1.6.21 Practice quality control	

STANDARD 2: Manual Machining Processes		
Topic 1: Measurement		
Introductory	**Core**	**Advanced**
2.1.1 Measure to 1/64” (0.5mm) with a steel rule 2.1.2 Measure to 0.0001 (0.002mm) using a Vernier micrometer caliper 2.1.3 Measure angles to 0◦5” using a universal Vernier bevel 2.1.4 Demonstrate use various types of gauges found in a machine shop 2.1.5 Demonstrate measurement transfer tools found in a machine shop		
Topic 2: Safety		
Introductory	**Core**	**Advanced**
2.2.1 Summarize why shop safety is important 2.2.2 Explain why it is important to develop safe work habits 2.2.3 Identify and correct unsafe work practices 2.2.4 Apply safe work practices when employed in a machine shop 2.2.5 Select the appropriate fire extinguisher for a particular type of fire 2.2.6 Use layout tools safely 2.2.7 List safety rules for layout work 2.2.8 Explain how to use hand tools safely		

Topic 3: Drawing and Layout		
Introductory	**Core**	**Advanced**
2.3.1 Read drawings that are dimensioned in fractional inches, decimal inches, and in metric units 2.3.2 Explain the information found on a typical drawing 2.3.3 Describe how detail, subassembly, and assembly drawings differ 2.3.4 Explain why drawings are numbered 2.3.5 Explain the basics of geometric dimensioning and tolerancing 2.3.6 Explain why layouts are needed 2.3.7 Create basic layouts		
Topic 4: Metal Characteristics		
Introductory	**Core**	**Advanced**
2.4.1 Discuss how metals are classified 2.4.2 Discuss ferrous metals 2.4.3 Discuss nonferrous metals 2.4.4 Discuss copper based metals 2.4.5 Discuss high temperature metals 2.4.6 Discuss rare metals 2.4.7 Discuss heat-treatable metals 2.4.8 Discuss types of heat-treatment	2.4.9 Demonstrate hardening of carbon steel 2.4.10 Demonstrate tempering of carbon steel 2.4.11 Demonstrate case hardening of steel	2.4.12 Describe hardness testing 2.4.13 Describe metal finishing techniques and quality of machined surfaces
Topic 5: Drills and Drilling Machines		
Introductory	**Core**	**Advanced**
2.5.1 Understand the use of cutting fluids 2.5.2 Discuss drills and drill machine safety 2.5.3 Describe drills, drill holding devices and work holding devices 2.5.4 Describe cutting speeds and feeds 2.5.5 Demonstrate drilling	2.5.6 Demonstrate counter sinking, counterboring, spotfacing, tapping and reaming.	

Topic 6: Offhand Grinding		
Introductory	**Core**	**Advanced**
2.6.1 Discuss abrasive belt and grinder safety 2.6.2 Define abrasive, bench and pedestal grinders, and portable hand grinders 2.6.3 Discuss grinding wheels and wet and dry type grinders 2.6.4 Discuss precision grinding 2.6.5 Observe grinding safety procedures	2.6.6 Demonstrate the proper use of all shop grinding machines 2.6.7 Demonstrate the procedure to precision grind a square block	
Topic 7: Sawing and Cutoff Machines		
Introductory	**Core**	**Advanced**
2.7.1 Discuss metal-cutting saws 2.7.2 Discuss reciprocating power hacksaw 2.7.3 Discuss power band saws 2.7.4 Demonstrate using power metal cutting saws 2.7.5 Discuss circular metal-cutting saws 2.7.6 Observe power saw safety		
Topic 8: The Lathe		
Introductory	**Core**	**Advanced**
2.8.1 Identify lathe size and major parts 2.8.2 Prepare the lathe for operation 2.8.3 Demonstrate cleaning the lathe 2.8.4 Observe lathe safety 2.8.5 Identify cutting tools and tool holders 2.8.6 Identify cutting speeds and feeds	2.8.7 Demonstrate turning work between centers 2.8.8 Demonstrate using lathe chucks 2.8.9 Demonstrate facing stock held in chuck 2.8.10 Demonstrate plain turning and turning to a shoulder 2.8.11 Demonstrate parting operations 2.8.12 Demonstrate taper turning 2.8.13 Demonstrate cutting screw threads on a lathe 2.8.14 Demonstrate boring on a lathe 2.8.15 Demonstrate drilling and reaming on a lathe 2.8.16 Demonstrate knurling on a lathe 2.8.17 Demonstrate filing and polishing on a lathe	2.8.18 Demonstrate the use of mandrels 2.8.19 Demonstrate the use of steady and follower rests 2.8.20 Discuss the special lathe operations and industrial applications of the lathe

Topic 9: Broaching Operations		
Introductory	**Core**	**Advanced**
		2.9.1 Discuss advantages of broaching 2.9.2 Demonstrate keyway broaching 2.9.3 Observe safety precautions when making a keyway
Topic 10: The Milling Machine		
Introductory	**Core**	**Advanced**
2.10.1 Identify types of milling machines 2.10.2 Observe milling safety practices 2.10.3 Identify types of milling operations and types and uses of milling cutters 2.10.4 Identify methods of milling 2.10.5 Identify milling cutting feeds and speeds. 2.10.6 Identify Discuss cutting fluids and work holding attachments	2.10.7 Demonstrate the procedure for squaring a mill vise 2.10.8 Demonstrate squaring stock using a flycutter 2.10.9 Demonstrate drilling, boring and reaming operations on the mill	2.10.10 Demonstrate the procedure to locate end mill to cut keyseat or slot on round work 2.10.11 Demonstrate how to cut a spur gear

STANDARD 3: Welding

Topic 1: Safety

Introductory	Core	Advanced
3.1.1 Demonstrate use of personal safety practices 3.1.2 Demonstrate proper use of safety clothing 3.1.3 Describe and recognize fire hazards 3.1.4 Describe and recognize electrical hazards 3.1.5 Use designated welding and cutting areas	3.1.6 Identify machinery hazards 3.1.7 Evaluate air quality in regard to fumes and ventilation 3.1.8 Demonstrate safe and correct use of hand and power tools	3.1.9 Demonstrate proper lifting techniques 3.1.10 Identify hazardous obstacles 3.1.11 Identify suffocation hazards 3.1.12 Identify potential hazards of welding on containers 3.1.13 List hazards posed by metals 3.1.14 Use safety welding precautions followed in industry

Topic 2: Measurement

Introductory	Core	Advanced
3.2.1 Read US conventional measure 3.2.2 Read metric measure	3.2.3 Explain how metals are measured and purchased for industrial use	

Topic 3: Drawings

Introductory	Core	Advanced
3.3.1 Produce drawings using sketching techniques 3.3.2 Create three view drawings 3.3.3 Produce orthographic projection drawings 3.3.4 Identify the alphabet of lines 3.3.5 Identify basic AWS weld symbols 3.3.6 Interpret arrow side and other side	3.3.7 Interpret working drawings 3.3.8 Give examples of US conventional units of measurement 3.3.9 Give examples of SI metric units of measurement 3.3.10 Convert US conventional units of measurement to SI metric units 3.3.11 Convert SI metric units of measurement to US conventional units	

Topic 4: Materials

Introductory	Core	Advanced
3.4.1 Explain how metals are classified 3.4.2 Describe properties and characteristics of various metals	3.4.3 Identify how metals and alloys are developed 3.4.4 Describe characteristics of various types of steel	3.4.5 Distinguish materials appropriate to the application

Topic 5: Tools		
Introductory	**Core**	**Advanced**
3.5.1 Identify oxy/fuel gas welding equipment and its uses 3.5.2 Identify shielded metal arc welding equipment and its uses 3.5.3 Identify gas metal arc welding equipment and its uses	3.5.4 Demonstrate oxy/fuel gas welding equipment and its uses 3.5.5 Demonstrate shielded metal arc welding equipment and its uses 3.5.6 Demonstrate gas metal arc welding equipment and its uses 3.5.7 Identify gas tungsten arc welding equipment and its uses	3.5.8 Demonstrate gas tungsten welding equipment and its uses
Topic 6: Welding Processes		
Introductory	**Core**	**Advanced**
3.6.1 Identify a weaving bead, a stringer bead, a groove weld, and a fillet weld. 3.6.2 List the four welding positions (flat, horizontal, vertical, overhead) 3.6.3 Identify five basic weld joints (butt, lap, corner, t and edge) 3.6.4 Identify the types of weld that can be made on each of the five basic weld joints 3.6.5 Create examples of the five basic weld joints using OFW, SMAW and GMAW processes in flat position	3.6.6 Create examples of the five basic weld joints using, SMAW and GMAW processes in position one through four.(flat, horizontal, vertical, overhead) using 6010, and 7018 rod 3.6.7 Create examples of OFC on various thickness of steel 3.6.8 Create examples of PAC on various metals 3.6.9 Create examples of Oxy/Fuel brazing 3.6.10 Create examples of Oxy/Fuel braze welding	3.6.11 Interpret the parts of a fillet weld 3.6.12 Interpret the parts of a groove weld 3.6.13 Interpret a stringer bead 3.6.14 Interpret a weaving bead 3.6.15 Create skilled examples of the five basic weld joints using SMAW and GMAW processes in position one through four. (flat, horizontal, vertical, overhead) using 6010 and 7018 rod 3.6.16 Create skilled examples of multi-pass welds using 6010 and 7018 rod in all positions
Topic 7: Welding Theory		
Introductory	**Core**	**Advanced**
3.7.1 Cite advantages of welding over other joining processes 3.7.2 List the significant developments in the history of welding 3.7.3 Identify several occupations in the welding industry and list the recommended amount of education for each	3.7.4 Identify the three general methods by which a weld is achieved 3.7.5 Describe the difference between chemical and mechanical properties of steel and give examples of each 3.7.6 Identify processes used to heat treat metal 3.7.7 Describe the relationship between voltage and current	3.7.8 Identify the basic types of welds indicated on the AWS welding symbol 3.7.9 Locate information on the weld symbol to determine the size of the root opening, the groove angle, and the desired size, contour, and finish of the weld 3.7.10 Describe the difference between a welding flaw and welding defect 3.7.11 List the most common types of

		nondestructive and destructive testing done on welds 3.7.12 Perform several basic types of tests on welds to evaluate weld quality 3.7.13 Describe the methods used to prepare samples for bend tests 3.7.14 Describe the use of codes and specifications to provide needed information on a required weld 3.7.15 Discuss the difference between a welding procedure specification and a welding performance qualification 3.7.16 Explain why a welder must often pass a number of welding performance qualifications 3.7.17 List the steps that must be followed to conform to the most codes

STANDARD 4: Automated Manufacturing		
Topic 1: Computer Aided Machining Technology		
Introductory	**Core**	**Advanced**
4.1.1 Retain this section, no CNC equipment at this time.		
Topic 2: Automated Manufacturing		
Introductory	**Core**	**Advanced**
4.2.1 Define PLC (programmable logic control) functions. 4.2.2 Explain PLC applications	4.2.3 Create a PLC demonstration	

STANDARD 5: Force and Force Transformers		
Topic 1: Mechanical		
Introductory	**Core**	**Advanced**
5.1.1 Describe what "force" is 5.1.2 Give examples of complex technological devices where force must be controlled, measured or applied 5.1.3 Describe what force, pressure, voltage and temperature difference have in common 5.1.4 Describe what happens in mechanical, fluid, electrical and thermal systems when forces are balanced and when forces are unbalanced 5.1.5 Name units of force used in mechanical, fluid, thermal, and electrical systems using System International (SI) and the English measuring units 5.1.6 Define the following: scalar, vector, weight, mass and torque 5.1.7 Determine the resultant, given two or more vectors, using appropriate sacel diagrams 5.1.8 Describe torques's relationship to clockwise and counterclockwise movement 5.1.9 Solve torque problems, given force and lever arm information 5.1.10 Describe a situation where technicians have to measure and apply forces in a mechanical system		

Topic 2: Electrical		
Introductory	**Core**	**Advanced**
5.2.1 Describe the three parts of electricity 5.2.2 Translate the resistor color code into numerical units of resistance 5.2.3 Solve for voltage, amperage, or resistance using OHM's Law 5.2.4 Describe conductors, insulators, and semiconductors 5.2.5 Differentiate between AC and DC current 5.2.6 Identify the most common source of DC voltage 5.2.7 Describe the sequence for connecting a DC circuit in series that will cause the voltages to be added 5.2.8 Identify three components of a circuit, giving their symbols, including a source, conductor and load 5.2.9 Describe how frequency and hertz relate to AC current 5.2.10 Briefly describe a situation that requires a technician to measure voltage	5.2.11 Build a printed circuit board 5.2.12 Construct a continuity tester 5.2.13 Evaluate electronic components for functionality using appropriate testing equipment 5.2.14 Complete lessons 1 - 15 as described in the Tronix 1 Basic Electronics "Fundamental Concepts" student lab manual.	5.2.15 Complete lessons 1-10 as described in the Tronix 5 Digital Concepts and Operational Amplifiers Course.
Topic 3: Fluid Force		
	Core	**Advanced**
5.3.1 Differentiate between hydraulic and pneumatic systems 5.3.2 Determine the density of a substance, given its mass and volume 5.3.3 Determine the specific gravity of a substance, given its density and the density of water 5.3.4 Define buoyant force 5.3.5 Define pressure. 5.3.6 Explain atmospheric pressure	5.3.14 Fluid power training activities (to be arranged)	

5.3.7 Find pressure, force or area, using the formula, p=F/A, given any two quantities in the formula 5.3.8 Describe the difference between absolute and gauge pressure 5.3.9 Explain how pressure in a fluid depends on depth of fluid 5.3.10 Describe how fluid pressure is a force like quantity 5.3.11 Describe fluid motion 5.3.12 Explain how manometers are used to measure pressures 5.3.13 Describe how to measure and/or control pressure in a fluid system		
Topic 4: Thermal Force		
Introductory	**Core**	**Advanced**
5.4.1 Identify the direction of movement of heat energy in a thermal system, when temperature information is known 5.4.2 List and describe the force like quantity in a thermal system 5.4.3 Define temperature 5.4.4 Describe the relationship between heat energy and molecular motion 5.4.5 Describe how heat energy moves through a system 5.4.6 Given Celsius or Fahrenheit temperatures and the formula for conversion, find the equivalent temperature on the alternate scale 5.4.7 Describe when the degree symbol should follow or precede the “F” or “C” abbreviation 5.4.8 Describe how a thermocouple thermometer measures temperature 5.4.9 Describe a situation that requires a technician to control temperature		